

## Fluctuations in numbers of deaths by week

Vital Events statistics are produced from complete counts of all the events which were registered, and so are not subject to some of the kinds of errors that may affect the results of sample surveys. However, the total numbers of deaths registered across Scotland as a whole may be subject to large percentage fluctuations if they relate to a short period (such as a week), due to both natural variation and factors (such as public holidays) which affect the arrangements for registering deaths. It follows that the figure for any given week may be an unreliable indicator of the usual weekly number of deaths, and that the change over a few weeks may be an unreliable indicator of any trend in the number of deaths. This note illustrates these points using the numbers of deaths registered, week by week, from 2003 to 2008 (the years for which the National Records of Scotland (NRS), formerly the General Register Office for Scotland (GROS), conducted the analysis whose results are described below). A workbook containing the charts and the underlying tables is available via a link at the foot of the page.

[Chart 1](#) shows how the number of deaths registered, week by week, in 2008 (the black line) compared with the seasonal pattern of the previous five years (the continuous grey line), and the likely range of week-to-week fluctuation around that seasonal pattern (the area between the two broken grey lines). The chart shows only weeks 5 to 48 because of the effect of the public holidays at Christmas and New Year on the figures for the weeks at the start and end of each year. How the weeks are defined is explained in the '[Date of registration is basis of Vital Events statistics](#)' section. How the range was produced is described in the lower part of this page.

The seasonal pattern shows clearly that fewer deaths are registered per week in the summer than in the winter. For example, the seasonal pattern shows fewer than 1,000 deaths per week from week 27 to week 37 (between around the start of July and mid-September) compared with about 1,150 to 1,200 deaths per week from week 5 to week 9 (broadly speaking, February). We can be confident that there is a real difference between the numbers of deaths registered per week in summer and in winter, because these figures are based on data for several years and so should not be affected greatly by unusual circumstances in any one year.

The chart also shows that the number of deaths registered in each week in 2008 was generally similar to the number that would be expected from the seasonal pattern - but sometimes it rose or fell quite sharply between one week and the next. There were some runs of weeks which all had more deaths registered than would be expected from the seasonal pattern, and some with fewer. The fluctuations in the number of deaths were generally within the likely range of values (only eight of the 44 weeks had numbers of deaths registered which were outwith the likely range of values, and it can be seen from Chart 1 that none of them was greatly outwith the likely range of values).

There were fewer deaths registered in 2008 than in four of the previous five years, and the total for 2008 was about 1% below the annual average for 2003 to 2007. As a result, the number of deaths registered in each week in 2008 tended to be slightly below what would be expected on the basis of the seasonal pattern for the previous five years: the figure for 2008 was below the seasonal pattern in 30 of the 44 weeks shown, and it was below the lower limit in all eight of the cases where it was outwith the likely range of values. [Chart 2](#) shows the effect of scaling the seasonal pattern, using the ratio of the total for the relevant weeks in 2008 to the average of those weeks in 2003 to 2007. The lines for the seasonal pattern and for the likely range of values are lower, as a result of the scaling, and this

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produces a more balanced outcome. Chart 2 shows only seven cases where the figure for 2008 is outwith the likely range of values (four below the likely lower limit, and three above the likely upper limit), and the figure for 2008 is below the seasonal pattern in only 26 out of the 44 weeks.

### **Estimating the ‘seasonal pattern’ for each week, and its ‘likely range of values’**

The ‘likely range of values’ was produced by assuming that the number of deaths registered in each week represents the result of a [Poisson process](#) (a separate section provides more information about this). The underlying rate for each week was assumed to be the value of the seasonal pattern for that week, and this was calculated by taking the 5-week moving average of the weekly averages for the previous five years. The ‘likely range of values’ for each week was produced by calculating a rough ‘95% confidence interval’ around the seasonal pattern.

The estimation of the underlying rate did not use the figures for the first few and last few weeks of the year, because they were clearly affected by considerable fluctuations in the number of deaths registered in each week around Christmas and New Year, due to registration offices being closed on public holidays. The figures for some other weeks will also be affected by public holidays (e.g. those at Easter), but it was decided not to exclude those weeks because: first, examination of the figures for each week suggested that the effect of other public holidays was nothing like as great as that of Christmas / New Year; second, it would be very difficult to exclude all public holidays because, for example, the date of Easter varies from year to year, and the dates of local holidays vary across Scotland; and, third, excluding all the weeks which might be affected by holidays would reduce greatly the number of weeks for which the seasonal pattern could be estimated.

The seasonal patterns were estimated using 5-week moving averages of the individual weeks' averages (which were produced from the figures for the five years 2003 to 2007, inclusive). This was done because [Chart 3](#) shows that the individual weeks' averages could fluctuate from week to week, whereas what was required was a seasonal pattern that would vary smoothly throughout the year.

Given the definition of a ‘95% confidence interval’, one would expect only about one in twenty cases to have a value which is outwith the likely range of values - so one would expect only a couple of weeks to have values outwith the likely range. Seven or eight values outwith the likely range is clearly more than one would expect: this may be due to (e.g.) the effect on the registration process of ‘non-random’ factors, such as Easter and other public holidays, and the fact that deaths do not occur ‘at random’ (e.g. a bad car crash may cause several deaths), so the actual fluctuations are a little greater than would be expected from a Poisson process. However, Charts 1 and 2 do not show any individual weeks' figures which are far outwith the likely range of values, so (in terms of the statistics) a Poisson process provides a reasonably good description of the numbers.

The workbook containing the charts and the underlying tables is available at the following link:

[Fluctuations in numbers of deaths by week](#) (Excel – 92 Kb)